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Indian Standard

SPECIFICATION FOR INDOOR POST INSULATORS OF ORGANIC MATERIAL FOR SYSTEMS WITH NOMINAL VOLTAGES GREATER THAN 1 000 V UP TO AND INCLUDING 300 kV

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Indian Standard

SPECIFICATION FOR INDOOR POST INSULATORS OF ORGANIC MATERIAL FOR SYSTEMS WITH NOMINAL VOLTAGES GREATER THAN 1 000 V UP TO AND INCLUDING 300 kV

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Indian Standard

SPECIFICATION FOR INDOOR POST INSULATORS OF ORGANIC MATERIAL FOR SYSTEMS WITH NOMINAL VOLTAGES GREATER THAN 1 000 V UP TO AND INCLUDING 300 kV

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 16 November 1979, after the draft finalized by the Electrical Insulators and Accessories Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard has been prepared with a view to achieve the following objects:

a) to define the terms used,
b) to define the electrical and mechanical characteristics of post insulators of organic material and to prescribe the conditions under which the specified values shall be verified,
c) to define methods of tests, and
d) to prescribe acceptance criteria.

NOTE — This standard does not give numerical values for insulator characteristics, neither does it deal with the choice of post insulators for specific operating conditions. IS : 2544-1973* and IS : 5350 (Part I)-1970† specify numerical values for electrical and mechanical characteristics and give the dimensions necessary for interchangeability of post insulators

0.3 The present standard applies to post insulators of cast epoxy resin for which a long experience is available. Provisionally, it may also be used as a guide for the minimum test requirements on post insulators of other organic materials. When enough experience is gained in those other organic materials, it will be possible, if necessary, to modify the present standard.

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*Specification for porcelain post insulators for systems with nominal voltages greater than 1 000 volts (*first revision*).

†Dimensions of indoor and outdoor porcelain post insulators and post insulator units for system with nominal voltages greater than 1 000 V: Part I Indoor post insulators.

0.4 In the preparation of this standard, assistance has been derived from IEC Document 36C (C.O.) 28 Tests on indoor post insulators of organic material for systems with nominal voltages greater than 1 000 V up to and including 300 kV, issued by the International Electrotechnical Commission (IEC).

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the requirements of post insulators of organic material for indoor service in electrical installations or equipment operating in air at atmospheric pressure on alternating current with a rated voltage greater than 1 000 V up to and including 300 kV and a frequency not greater than 100 Hz.

NOTE — The post insulators covered by this standard are primarily intended for use in disconnectors or circuit breakers, or as bus-bar or fuse supports.

2. TERMINOLOGY

2.1 For the purpose of this standard, the following definitions and those covered in IS : 2071 (Part I)-1974† shall apply.

2.1.1 *Post Insulator of Organic Material* — A post insulator is intended to give rigid support to a live part which is to be insulated from earth or from another live part. The whole or part of material composing of post insulator consists of organic materials, that is of material pertaining to the chemistry of the compounds produced from carbon or to the chemistry of the compounds produced from carbon and silicon. These organic materials may be used alone or in conjunction with other materials designated as fillers. The fillers may be mineral or organic.

2.1.2 *Indoor Post Insulators* — Indoor post insulators are intended to be installed indoors where they are not subject to excessive condensation.

NOTE — For indoor installations subject to excessive condensation outdoor insulators or special indoor insulators may be used.

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*Rules for rounding off numerical values (*revised*).

†Methods of high voltage testing: Part I General definitions and test requirements (*first revision*).

2.1.3 *Lot* — All the insulators of the same type and design manufactured under similar conditions of production, offered for acceptance; a lot may consist of the whole or part of the quantity ordered.

2.1.4 *Type Tests* — Tests carried out to prove conformity with the specification. These are intended to prove the general qualities and design of given type of insulator.

2.1.5 *Acceptance Tests* — Tests carried out on samples taken from the lot for the purpose of acceptance of the lot.

2.1.6 *Routine Tests* — Tests carried out on each insulator to check requirements which are likely to vary during production.

2.1.7 *Creepage Distance of a Post Insulator* — The creepage distance of a post insulator is the shortest distance along the contours of the external surfaces of the insulating parts of the post insulator between those parts which normally have the operating voltages between them. However, to take account of the metal fittings attached to the post insulator, the distance corresponding to the post insulator cross-section in contact with the metal fittings shall not be included in the creepage distance.

If high resistance coatings are applied to the insulators, such coatings shall be considered as effective creepage surfaces and the distance over them shall be included in the creepage distance.

NOTE 1 — The surface resistivity of such high-resistance coatings is usually about 10^6 M.Ω.

NOTE 2 — If high-resistance coatings are applied over the whole surface of the post insulator, the questions of surface resistivity and creepage distance shall be subject to agreement between the manufacturer and the purchaser.

NOTE 3 — Creepage distance is normally not specified.

2.1.8 *Mechanical Failing Load* — The mechanical failing load is the maximum load which can be reached when a post insulator is tested under the conditions prescribed in **9.6**. It corresponds to the maximum load of a load deflection curve.

NOTE — The statistical sampling method for mechanical tests is under consideration.

2.1.9 *Flashover* — Flashover is a disruptive discharge external to the post insulator, connecting those parts which normally have the operating voltage between them.

NOTE — The term 'flashover' used in this standard includes flashover across the insulator surface as well as disruptive discharge by sparkover through air adjacent to the insulator. Disruptive discharges should only occur occasionally elsewhere (for instance other than to structures or to earth), in which case they should not be taken into account for the purposes of this standard.

2.1.10 *Puncture* — Puncture is a disruptive discharge passing through the insulating parts of a post insulator.

NOTE — A fragment breaking away from the rim of a shed or damage to the insulator due to the heat of a surface discharge shall not be considered as a puncture.

2.1.11 *Dry Lightning Impulse Withstand Voltage* — The lightning impulse voltage which the post insulator shall withstand dry under the prescribed conditions of test.

2.1.12 *Fifty Percent Dry Lightning Impulse Flashover Voltage* — The value of the lightning impulse voltage which has a 50 percent probability of producing flashover on the post insulator dry under the prescribed conditions of test.

2.1.13 *Dry Power Frequency Withstand Voltage* — The power frequency voltage which the post insulator withstands dry under the prescribed conditions of test.

2.1.14 *Dry Power Frequency Flashover Voltage* — The arithmetic mean value of the measured voltages which cause flashover of the post insulator dry under the prescribed conditions of test.

3. NORMAL SERVICE CONDITIONS

3.1 Normal temperature and relative humidity service conditions are as follows:

a) The ambient air temperature does not exceed 40°C and its average value, measured over a period of 24 h, does not exceed 35°C.

b) The minimum ambient air temperature is −5°C or alternatively −20°C.

c) The altitude does not exceed 1 000 m.

d) The ambient air is not materially polluted by dust, smoke, corrosive or flammable gases and vapours, or salt.

e) The average value of the relative humidity, measured over a period of 24 h, does not exceed 95 percent.

f) The average value of the relative humidity, measured during a period of one month, does not exceed 90 percent.

NOTE — For these maximum relative humidity and temperature conditions of 95 percent and 40°C respectively condensation occurs for a decrease in temperature of the post insulators of 2°C.

4. REFERENCE ATMOSPHERIC CONDITIONS FOR TESTS

4.1 For high voltage tests, standard atmospheric conditions are as follows, in accordance with IS : 2071 (Part I)-1974*:

Ambient temperature, t_0	20°C
Atmospheric pressure, b_0	$1\ 013 \times 10^5$ N/m^2 (1 013 mbar)
Humidity, h_0	11 g water per m^3

NOTE — The pressure 1 013 mbar corresponds to a height of 760 mm in a mercury barometer at 0°C. If barometric height is h mm of mercury, the atmospheric pressure is approximately:

$$b = \frac{1\,013\,h}{760} \text{ mbar}$$

4.2 Tests for the purpose of this standard shall preferably be carried out under conditions of temperature and humidity specified in IS : 196-1966† (that is, a temperature of 27 ± 2°C and relative humidity of 65 ± 2 percent), and at the prevailing atmospheric pressure. When this is not possible, test may be carried out under conditions naturally obtaining at the time of the test. The barometric pressure, air temperature and humidity shall be recorded for the purpose of corrections. Corrections of test voltages for atmospheric conditions is given in Appendix A.

5. CLASSIFICATION

5.1 Post insulators of organic material are divided into following two types according to their construction:

Type A — A post insulator in which the length of the shortest puncture path through solid insulating material is at least equal to one third the length of the shortest flashover path through air outside the insulator for cast epoxy resins and one half of this length for other organic materials.

Type B — A post insulator in which the length of the shortest puncture path through solid insulating material is less than one third the length of the shortest flashover path through air outside the insulator for cast epoxy resins and one half of this length for other organic materials.

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*Methods of high voltage testing: Part I General definitions and test requirements (*first revision*).

†Specification for atmospheric conditions for testing (*revised*).

6. SPECIFIED CHARACTERISTICS

6.1 A specified characteristic is either:

a) the numerical value of the voltage or of the mechanical load or any other characteristic specified in this standard or IS : 2544-1973* or IS : 5350 (Part I)-1970†, or

b) the numerical value of any such characteristic agreed between the manufacturer and the purchaser.

6.1.1 Specified withstand and flashover voltages and mechanical loads are referred to standard atmospheric conditions.

7. VALUES WHICH CHARACTERIZE A POST INSULATOR OF ORGANIC MATERIAL

7.1 A post insulator of organic material is characterized by the following values when applicable:

a) the specified dry lightning impulse voltage,

b) the specified dry one-minute power frequency withstand voltage,

c) the specified mechanical failing load,

d) the specified significant dimensions, and

e) the maximum difference between the deflection at 20 percent and 50 percent of the specified load.

NOTE 1 — Service voltage is not to be considered as a characteristic of a post insulator.

NOTE 2 — If requested, a design drawing of the insulators should be submitted.

NOTE 3 — The flashover and withstand voltages of insulators under normal service conditions may differ from the voltages under standard testing conditions.

8. VALUES OF TEST VOLTAGES

8.1 In accordance with IS : 2071 (Part II)-1976‡ lightning and switching impulse voltages shall be expressed by their prospective peak values. Power frequency voltages shall be expressed as peak values divided by $\sqrt{2}$.

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*Specification for porcelain post insulators for systems with nominal voltages greater than 1 000 volts (*first revision*).

†Dimensions of indoor and outdoor porcelain post insulators and post insulator units for system with nominal valtages greater than 1 000 V: Part I Indoor post insulators.

‡Methods of high voltage testing: Part II Test procedures (*first revision*).

9. TESTS

9.1 General

9.1.1 *Type Tests* — The following tests shall constitute the type tests and shall be carried out when applicable:

a) Dry lightning impulse withstand voltage test (**9.2**),
b) Dry power frequency withstand voltage test (**9.3**),
c) Partial discharge test (**9.4**),
d) Lightning impulse puncture test (**9.5**),
e) Test for mechanical strength in standard temperature conditions (**9.6**),
f) Measurement of deflection under load in standard temperature conditions (**9.7**),
g) Test for mechanical bending strength as a function of temperature (**9.8**),
h) Water absorption test (**9.9**),
j) Ageing and humidity test (**9.10**),
k) Flammability test (**9.11**),
m) Temperature cycle test (**9.12**),
n) Verification of dimensions (**9.13**),
p) Visual examination (**9.14**).

NOTE 1 — Type tests are normally made once for each cast epoxy resin material and method of manufacture and unless otherwise agreed to, test certificate giving the results of type tests, made on not less than two insulators identical in all essential detail with those supplied, are regarded as evidence of compliance. These tests shall be repeated only when the material or design of the insulator is changed.

NOTE 2 — Type tests on post insulators of the same cast epoxy resin made by the same manufacturing method are divided into following three sub-groups according to their applicability:

a) Tests related to the choice of expoxy resin and the method of manufacture. The following tests shall normally be performed once only on a representative post insulator of each material made by the same manufacturing method:

    1) Water absorption test (**9.9**),
    2) Flammability test (**9.11**), and
    3) Ageing and humidity test (**9.10**).

b) Tests related mainly to the choice of epoxy resin and method of manufacture, but which may be influenced by the design of the post insulator. The following test shall normally be performed once only on insulators of similar shape made from the same material by the same manufacturing method:

Test for mechanical bending strength as a function of temperature (**9.8**).

c) Tests related to the particular design of the post insulator. The following tests shall be performed once only on each design of post insulator:

1) Dry lightning impulse withstand voltage test (**9.2**),
2) Dry power frequency withstand voltage test (**9.3**),
3) Lightning impulse puncture test (**9.5**),
4) Temperature cycle test (**9.12**),
5) Partial discharge test (**9.4**),
6) Measurement of deflection under load in standard temperature conditions (**9.7**), and
7) Test for mechanical strength in standard temperature conditions (**9.6**).

When this standard is applied to post insulators or organic material other than cast epoxy resin all the tests in each sub-group shall be repeated for each design of insulator.

NOTE 3 — Type tests shall be made and certified by either the manufacturer or by an independent authority as mutually agreed upon.

9.1.2 *Acceptance Tests* — The number of samples for these tests shall be in accordance with Appendix B. The purchaser has the right to make the selection.

9.1.2.1 The test samples shall first withstand the routine tests specified in **9.1.3**. They shall then be subject to the following acceptance tests in the order given:

a) Verification of dimensions (**9.13**),

b) Water absorption tests (for materials other than cast epoxy resin only) (**9.9**),

c) Partial discharge test (**9.4**),

d) Test for deflection under load in standard temperature conditions (**9.7**), and

e) Test for mechanical strength in standard temperature conditions (**9.6**).

In the event of a post insulator failing to meet any of the acceptance tests, re-testing in accordance with **9.1.2.2** may be carried out.

9.1.2.2 *Re-test procedure* — If only one post insulator fails to comply with any one of the acceptance tests specified in **9.1.2.1** a new quantity equal to twice the quantity originally submitted to that test shall be submitted to re-testing.

If two or more post insulators fail to comply with any of the acceptance tests as prescribed in **9.1.2.1**, or if any failure occurs on post insulators subject to re-testing as described above, the complete lot shall be withdrawn for further examination by the manufacturer. After that new examination, the lot or part thereof may be re-submitted for test.

The number then selected shall be equal to three times the quantity originally submitted for that test.

The re-testing shall comprise the test in which failure occurred preceded by those tests of **9.1.2.1** which may be considered to have influenced the results of the original test.

If any failure occurs on post insulators re-submitted for test, the complete lot shall be deemed not to comply with this standard.

9.1.3 *Routine Tests* — Every post insulator shall pass those of the following tests which are applicable:

a) Visual examination (**9.14**),

b) Dry one-minute power frequency voltage withstand test for post insulators of Type B (**9.3**), and

c) After agreement between the manufacturer and the purchaser, one-minute power frequency voltage withstand test for post insulators of Type A (**9.3**).

9.1.4 *General Requirements for Electrical Tests*

9.1.4.1 *Standard mounting arrangements for all electrical tests* — The post insulator shall be mounted vertically upright on a horizontal earthed metal support, consisting of a channel section with the flanges pointing downwards. The earthed metal support shall have a width about equal to the diameter of the mounting face of the post insulator under test and a length at least equal to twice the height of the insulator, and shall be placed at least 1 m above ground for insulators not higher than 1·8 m. For higher post insulators the distance shall be at least 2·5 m.

A cylindrical conductor maintained in the horizontal plane perpendicular to the earthed support shall be attached to the other end of the post insulator. The length of the conductor shall be at least equal to 1·5 times the height of the insulator and it shall extend at least 1 m on each side of the insulator axis. The diameter of the conductor shall be approximately 1·5 percent of the height of the post insulator with a minimum of 25 mm.

9.1.4.2 *Mounting arrangement for all electrical tests when service conditions are to be represented* — When so agreed, tests may be made under conditions representing service conditions as closely as possible. The extent to which service conditions are simulated shall be agreed between manufacturer and purchaser, taking into account all factors which may influence insulator performance.

NOTE — Under these non-standard conditions, the characteristics may differ from values measured using the standard method of mounting specified in **9.1.4.1**. The differences may be considerable when dealing with post insulators with height greater than 1·8m or with reduced heights above ground.

9.1.4.3 *Time intervals between consecutive applications of the voltage* — The time intervals between consecutive applications of the voltage shall be sufficient to avoid effects from the previous application of voltage in flashover or withstand tests.

9.1.4.4 Lightning impulse voltages and power frequency voltage test methods shall be in accordance with IS : 2071 (Part II)-1976*.

When the natural atmospheric conditions at the time of test differ from the standard values (*see* **4**), it is necessary to apply correction factors in accordance with IS : 2071 (Part I)-1974†.

The insulators shall be clean and dry before starting the high voltage tests.

Precautions shall be taken to avoid condensation on the surface of the insulator, especially when the relative humidity is high. For example, the insulator shall be maintained at the ambient temperature of the test location for sufficient time for equilibrium to be reached before the test starts. Except by agreement between the manufacturer and the user, tests shall not be made if the relative humidity exceeds 85 percent.

---

*Methods of high voltage testing: Part II Test procedures (*first revision*).

†Methods of high voltage testing: Part I General definitions and test requirements (*first revision*).

9.1.4.5 *Lightning impulse voltage tests* — The standard 1·2/50 lightning impulse shall be used [*see* IS : 2071 (Part II)-1976*] with the following tolerances:

Peak value	± 3 percent
Front time	± 30 percent
Time to half value	± 20 percent

The value of the lightning impulse voltage shall be its peak value as measured by a sphere gap or another method prescribed in IS : 2071 (Part II)-1976*.

9.1.4.6 *Power frequency voltage tests* — The test voltage shall be an alternating voltage having a frequency in the range 15-100 Hz unless otherwise agreed between the manufacturer and the user.

The test circuit shall be in accordance with IS : 2071 (Part II)-1976*.

9.2 Dry Lightning Impulse Withstand Voltage Tests

9.2.1 The post insulator shall be tested under the conditions prescribed in **9.1.4.** The impulse generator shall be adjusted to produce a 1·2/50 impulse (*see* **9.1.4.4**).

Impulses of both positive and negative polarity shall be used. However, when it is evident which polarity will give the lower flashover voltage, it shall be sufficient to test with that polarity.

The following two test procedures are in common use for the lightning impulse withstand test:

a) The withstand procedure with 15 impulses, and

b) The 50 percent flashover voltage procedure.

NOTE — The 50 percent procedure gives more information.

9.2.2 *Withstand Test Using the Withstand Procedure* — The withstand test shall be performed at the specified voltage obtained by applying the correction for atmospheric conditions at the time of test (Appendix A). Fifteen impulses shall be applied. If the number of flashover does not exceed two, the post insulator is deemed to comply with this standard.

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*Methods of high voltage testing: Part II Test procedures (*first revision*).

The post insulators shall not be damaged by these tests, but slight marks on the surface of the insulating parts or chipping of the cement or other material used for assembly shall be permitted.

9.2.3 *Withstand Test Using the Fifty Percent Flashover Procedure* — The specified lightning impulse withstand voltage shall be verified from the 50 percent lightning impulse flashover voltage determined by the following procedure:

> A voltage U_k is chosen, believed to lie at or near the 50 percent flashover voltage level. A voltage interval $\triangle U$ approximately 3 percent of U_k is also chosen. One impulse is applied at the level U_k. If this does not cause flashover, the level of the next impulse should be $U_k + \triangle U$. If flashover occurs at the level U_k, the next impulse should have a level $U_k - \triangle U$. This procedure is repeated a number of times, each impulse having a level determined by the effect of the preceding impulse. The number of impulses n_v applied at each voltage level U_v is counted and the 50 percent flashover voltages is determined as:
>
> $$U_{50} = \frac{\Sigma n_v . \triangle U}{\Sigma n_v}$$
>
> In this equation, the first level taken into account should be one at which two or more impulses were applied; this partially corrects for the error which may be introduced if U_k is much too low or much too high. The total number of impulses taken into account (Σn_v) shall be equal to 30.
>
> The 50 percent lightning impulse flashover voltage determined by the above procedure shall be corrected in accordance with Appendix A. The post insulator passes the test if the 50 percent lightning impulse flashover voltage is not less than $\frac{1}{1-1{\cdot}3\delta} = 1{\cdot}040$ times the specified lightning impulse withstand voltage, where δ is the standard deviation assumed equal to 3 percent.
>
> The insulator shall not be damaged by these tests but slight marks on the surface of the insulating parts or chipping of the cement or other material used for assembly shall be permitted.
>
> NOTE — An alternative procedure to determine the 50 percent lightning impulse flashover voltage, which may be used mainly for research purposes, is the following:
>
> A number of lightning impulses are applied at each of several test voltage levels, the steps in voltage being 2-4 percent of the expected 50 percent flashover voltage. The value of the 50 percent flashover voltage is found from a curve of flashover probability *versus* prospective test voltage, obtained by plotting the test results on normal probability paper as straight line based on interpolation according to the least square law. The 50 percent flashover

voltage obtained by this procedure may be used for the purposes of this standard provided that at least 15 impulses are applied at each voltage level and at least 4 test voltage levels resulting in more than zero and less than 100 percent flashover are considered.

9.3 Dry Power Frequency Withstand Voltage Test

9.3.1 The post insulator shall be tested under the conditions prescribed in **9.1.4.**

The test voltage to be applied to the post insulator shall be the specified dry power frequency withstand voltage adjusted for the atmospheric conditions at the time of test (*see* Appendix A).

A voltage of about 75 percent of the test voltage so determined shall be applied and then increased gradually with a rate of rise of about 2 percent of the test voltage per second. The test voltage shall be maintained at this value for 1 min.

No flashover or puncture shall occur during the test.

To provide information when specially requested, the dry flashover voltage of the post insulator may be determined increasing the voltage gradually from about 75 percent of the dry power frequency withstand voltage with a rate of rise of about 2 percent of this voltage per second. The dry flashover voltage shall be the arithmetic mean of five consecutive readings and the value, after correction to standard atmospheric conditions (*see* **4.2**) shall be recorded.

9.4 Partial Discharge Extinction Voltage Test

9.4.1 Measurements of partial discharges of a post insulator shall be made to determine the power frequency voltage amplitude at which partial discharges cease in the solid insulation or in the interface between the insulation and metallic parts of the post insulator of organic material.

9.4.2 The procedure to be used for the measurement will be one of the procedures described in IS : 6209-1971*. The applied voltage at which partial discharges cease shall be not less than 10 percent higher than the highest voltage for equipment divided by $\sqrt{3}$.

9.4.3 After agreement between the manufacturer and the purchaser, a simplified procedure of comparable sensitivity may also be used, as described in **9.4.4.**

9.4.4 The only measuring instrument chosen is the cathode-ray oscillograph allowing the display of individual pulses as given in Appendix C of IS : 6209-1971*.

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*Methods for partial discharge measurements.

9.4.5 The test circuit is shown in Fig. 1 of this standard. The system also comprises, in addition to the apparatus necessary for the generation and measurement of the test high voltage of the following:

a) A high pass filter (Z_m) used to extract the high frequency voltage, it plays the part of a measuring impedance; and

b) A cathode-ray oscillograph used for the display of the high frequency voltage.

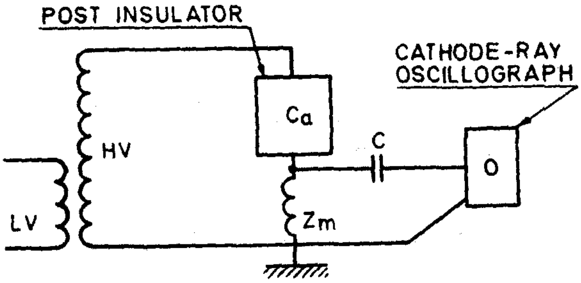

Fig. 1 Test Circuit for Partial Discharge Extinction Test Voltage

9.4.6 The whole testing system shall be discharge-free and preserved from extraneous disturbances.

9.4.7 The following procedure is applied for the measurement.

9.4.7.1 The power-frequency voltage applied to the post insulator is increased until the lines representing the high frequency discharges in the solid insulation of the post insulator are displayed. The voltage applied to the post insulator is reduced to a value at which the discharges cease, the value of the applied voltage corresponding to the extinction of discharges is noted.

9.4.7.2 In no case however shall the applied voltage exceed the power frequency withstand voltage specified for the post insulators in IS: 2544-1973*.

9.4.7.3 The value of the reactor with air core, designated (Z_m) in Fig. 1, may vary from 18 to 20 mH. The value of the capacitance, designated (C) in Fig. 1, may vary from 80 to 125 pF.

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*Specification for porcelain post insulators for systems with nominal voltages greater than 1 000 volts (*first revision*).

9.4.7.4 The cathode-ray oscillograph linear scanning is 1 ms. The oscillograph vertical amplification shall be such as to obtain a 1 cm deviation with 10 mV at the input. In such conditions, the frequency band is 20 Hz to 3·8 MHz at 3 dB.

9.4.7.5 Whatever the test circuit is the sensitivity of the measuring circuit shall allow detection of a 10 pC amplitude discharge.

9.5 Lightning Impulse Puncture Test

9.5.1 This test applies only to post insulators of Type B.

9.5.2 The post insulators, after having been cleaned and dried, shall be completely immersed in a tank containing a suitable insulating medium to prevent surface discharges on them. If the tank is made of metal, its dimensions shall be such that no sparkover occurs between the electrodes and the sides of the tank.

9.5.3 The test shall be carried out at normal temperature conditions of 20°C.

9.5.4 The impulse generator shall be adjusted to produce a 1·2/50 impulse (*see* **9.1.4.5**).

9.5.5 Five consecutive impulses of positive polarity and five consecutive impulses of negative polarity shall be applied to the post insulators. No puncture shall occur.

9.5.6 The test voltage value shall be equal to 1·3 times the impulse withstand voltage specified in IS : 2544 - 1973*.

9.6 Test for Mechanical Strength in Standard Temperature Conditions

9.6.1 The post insulator shall be attached to the mounting face of the testing machine by its normal method of mounting.

9.6.2 The load shall be applied gradually, starting from a value not greater than half the specified failing load, and shall be increased until the specified failing load is reached. The insulator passes the test if the specified failing load is reached without damaging the post insulator. When specially requested for additional information, the load may be increased until the failing load is reached and the value recorded.

9.6.3 An insulator which has been tested to its specified failing load shall not subsequently be used in service.

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*Specification for porcelain post insulators for systems with nominal voltages greater than 1 000 volts (*first revision*).

9.6.4 The test for mechanical strength of a post insulator shall consist of one of the following tests. Unless otherwise agreed, the test will be the bending test.

9.6.5 *Bending Test* — The bending load shall be applied to the end of the post insulator. The direction of loading shall pass through the axis of the insulator and shall be at right angles to it.

9.6.6 *Torsion Test* — The torsion load shall be applied to the free end of post insulator avoiding all bending moment.

9.6.7 *Tensile or Compressive Test* — The tensile or compressive load shall be applied along the axis of the post insulator.

NOTE 1 — Only the bending load values are specified in IS : 2544-1973*.

NOTE 2 — For guidance, rapid increase of the load may be applied between 0 and 75 percent of the value of the specified failing load. Then the rate of increase of the load per minute may be between 30 percent and 60 percent of the specified failing load.

9.7 Test for Deflection Under Load in Standard Temperature Conditions

9.7.1 The method for the test is as follows:

The post insulator shall be attached as described in **9.6** and shall be subjected to a load increased gradually starting from a zero value up to a value half the specified failing load. The deflection shall continuously be measured at the point at which the load or torsional load is applied.

The deflection load or torsional load characteristic curve is thus directly obtained.

NOTE — Only the maximum difference between the deflection at 20 percent and 50 percent of the specified failing load is specified in IS : 2544 - 1973*. When the bending load is removed, the residual deflection shall be less than 2 percent of the height.

9.8 Test for Mechanical Bending Strength as a Function of Temperature

9.8.1 Post insulators of organic material are required to operate satisfactorily in a wide range of ambient temperatures. Therefore it is necessary to determine the probable variation in mechanical strength caused by different temperatures. For this purpose only the mechanical bending strength test is employed.

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*Specification for porcelain post insulators for systems with nominal voltages greater than 1 000 volts (*first revision*).

The mechanical bending failing load test shall be carried out at the temperature range selected by the purchaser.

If the purchaser does not select a range, the second range shall be used. Within the temperature range chosen, the failing load shall be tested as a function of the temperature. Three temperature values shall be chosen within the range as follows:

a) −40°C, +20°C, +55°C;

b) −20°C, +20°C, +75°C; and

c) −5°C, +20°C, +90°C.

9.8.2 Three temperature ranges are defined as follows:

a) −40°C to +55°C,

b) −20°C to +75°C, and

c) −5°C to +90°C.

9.8.3 The mechanical bending failing load test shall be carried out at the temperature range selected by the purchaser. In the absence of selection by the purchaser, the second range shall be used.

9.8.4 Within the temperature range chosen, the failing load shall be tested as a function of the temperature. Three temperature values shall be chosen within the range as follows:

a) −40°C, +20°C, +55°C;

b) −20°C, +20°C, +75°C; and

c) −5°C, +20°C, +90°C.

9.8.5 At each of the selected temperatures, the mechanical failing load test in bending shall be carried out on a minimum of 10 insulators. From the measured failing loads the mean value ($\overline{R}$) and the standard deviation (s) shall be calculated. By plotting $\overline{R}$ against temperature together with further line (s) at $\overline{R} - a \times s$ the probability of a particular design of insulator of organic material achieving a minimum failing load at a selected temperature may be determined.

A normal value of '*a*' is 2, but greater or lesser values may be chosen by agreement between the purchaser and the manufacturer to give increased or decreased probabilities of meeting the minimum failing load.

9.8.6 The test method shall be such that when the failing load is reached the temperature does not vary from the chosen value by more than ± 5°C.

9.8.7 In particular, for post insulators of small dimensions up to 170 kV impulse voltage, the post insulator and the removable parts of the testing machine with which it is in contact shall be heated at the same time. The fixing arrangements of the testing machine shall be such as to have the hot post insulator installed in a time not exceeding one minute.

9.8.8 For large post insulators, a device shall be provided allowing the post insulator to be heated when it is installed on the testing machine and while the test is being carried out.

9.8.9 In the case of post insulators of a material likely to meet two or three temperature ranges, the test shall be carried out at the extreme temperatures of the two or three ranges and at 20°C.

9.8.10 After agreement between the manufacturer and the purchaser, provided that test results on post insulators of the similar design, the same material and the same manufacturing method already exist, the test has not to be carried out again.

9.9 Water Absorption Test

9.9.1 The post insulator, after having been cleaned shall be immersed to a depth of 0·1 m in a bath of distilled water for a period of 24 h at the normal temperature of 20°C. Then it shall be removed from the distilled water and left to dry in free air in the testing laboratory for 3 h. The post insulator fitted with its own electrodes shall be subjected to a power frequency voltage, equal to 80 percent of the flashover voltage before immersion for a period of one hour. The post insulator shall not undergo any flashover, or puncture, or superficial temperature rise exceeding 5°C as measured at the end of the test.

9.9.2 If test results on identical post insulators of same cast epoxy resin and same method of manufacturing are already available, the test need not be carried out again. For other organic materials, the question is under consideration whether test is to be repeated in case the test results are available on identical insulator.

9.10 Ageing and Humidity Test

9.10.1 An ageing test in a humid atmosphere and with voltage shall be carried out.

9.10.2 Various test methods are under consideration.

NOTE — After agreement between purchaser and manufacturer providing sufficient test result are available on post insulators made of the same material and the same manufacturing method the test shall not be repeated on a new design.

9.11 Flammability Test

9.11.1 The post insulator is mounted in its normal position, for instance upright. The flame of an oxy-acetylene pipe adjusted according to the state of the art, inclined at an angle of 45° to the axis of the post insulator, is so applied as to have the top of the blue flame in contact with the insulating material at half the height of the post insulator.

9.11.2 The flame is applied for 15 s, then removed for 15 s. The cycle is repeated five consecutive times. If the organic material of the post insulator is ignited it shall extinguish itself within 60 s.

The nozzle fitted to the oxy-acetylene pipe shall have a combustion mixture flow rate of 100 l/h, approximately 50 l/h of oxygen and 50 l/h of acetylene. The flame being chemically neutral will be about 150 mm along and shall be inclined from below:

If test results on identical post insulators of same cast epoxy resin already exist, the test has not to be carried out once again.

9.12 Temperature Cycle Test

9.12.1 The post insulator shall be placed in a chamber at a temperature of −25°C for a minimum of 10 h. The post insulator shall then be withdrawn from the previous chamber and quickly placed in a chamber heated to a temperature of +50°C for a minimum of 10 h. These two cycles shall be performed three times.

9.12.2 The post insulator shall then be visually examined to detect surface defects.

9.12.3 To detect possible cracks in the material composing the post insulator, the post insulator shall be subject to the partial discharge extinction voltage test (**9.4**). The partial discharge extinction voltage test may be replaced by the mechanical strength test by agreement between the manufacturer and the purchaser (**9.6**).

9.13 Verification of Dimensions

9.13.1 It shall be verified that the post insulator is in accordance with the relevant drawings, particularly as regards any dimensions to which special tolerances apply (for instance height) and detail affecting interchangeability (for instance, diameters of top and bottom fixing threads).

9.13.2 Unless otherwise specified, a tolerance of $\pm$ (0·01 d + 0·2) mm is allowed on all dimensions for which special tolerances do not apply (d being the dimensions in mm).

9.14 Visual Examination

9.14.1 The examination shall be made on each post insulator. The mounting of the metallic parts on the insulating parts shall be in accordance with the drawings. The colour of the post insulator shall approximate the colour specified on the drawing. Some variation in colour shade is permitted and shall not justify rejection of the insulator.

9.14.2 The insulating parts shall have no surface defects such as folds, blow holes, etc, prejudicial to satisfactory performance in service. A binocular glass of 20 to 30 magnifying power may be used for the examination.

9.15 Electrical Routine Test

9.15.1 Post insulators shall be subjected to a power frequency voltage applied across the metal parts normally subjected to electrical stress in service.

The test voltage shall be the voltage specified in IS : 2544-1973* for the dimensions of indoor post insulators of organic material.

The time of application of the test voltage shall be one minute. For the test the insulators may be mounted in a suitable manner but not necessarily in accordance with **9.1.4**. The test may be performed on any number of insulators simultaneously. Post insulators which are damaged during the test shall be rejected.

APPENDIX A

(*Clauses* 4.2, 9.2.2, 9.2.3 *and* 9.3.1)

CORRECTION FACTORS FOR ATMOSPHERIC CONDITIONS

A-1. CORRECTION FACTORS

A-1.1 Withstand and flashover voltages depend on the atmospheric conditions at the time of the test; if these differ from the selected standard conditions; correction factor k_d (air density) and k_h (humidity) shall be

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applied as follows to obtain the voltage to be applied in a withstand test or the voltage to be recorded in a flashover test:

Test		*Correction*
Dry lightning impulse voltage	Withstand	Multiply specified withstand voltage by k_d and divide by k_h
	Flashover	Divide measured flashover voltage by k_d and multiply by k_h
Dry power frequency voltage	Withstand	Multiply specified withstand voltage by k_d and divide by k_h
	Flashover	Divide measured flashover voltage by k_d and multiply by k_h

A-2. Air Density Correction Factor k_d

A-2.1 With the atmospheric pressure b expressed in millibars and the temperature t expressed in degrees Celsius, the following air density correction factors apply:

- dry lightning impulse test, positive and negative polarity $k_d = \delta$
- dry power-frequency test $k_d = \delta^m$

where

$$\delta = 0{\cdot}289 \frac{b}{273+t}$$

m is the exponent given in Fig. 2 as a function of the insulating distance d.

A-3. Humidity Correction Factor k_h

A-3.1 The following correction factor shall be applied:

- dry lightning impulse test
  positive polarity: k_h given by curve b in Fig. 3.
  negative polarity: k_h given by curve c in Fig. 3.
- dry power-frequency test k_h given in Fig. 4.

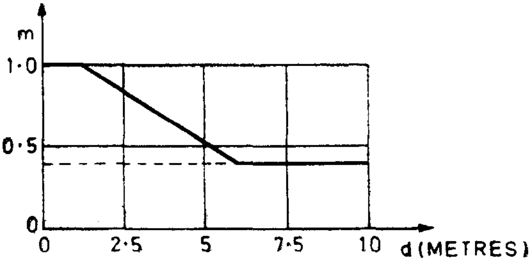


FIG. 2 CORRECTIONS FOR AIR DENSITY — EXPONENT *m versus* INSULATING DISTANCE *d* IN METRES

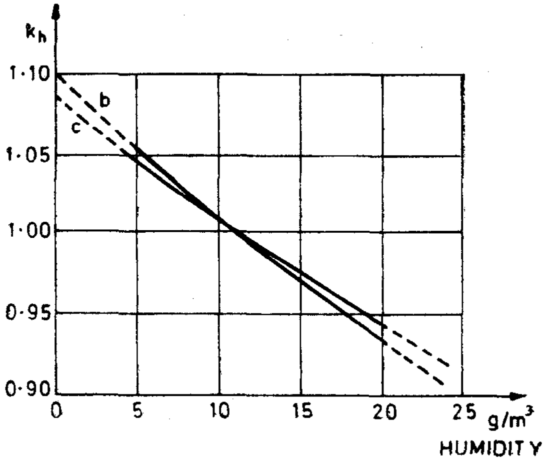
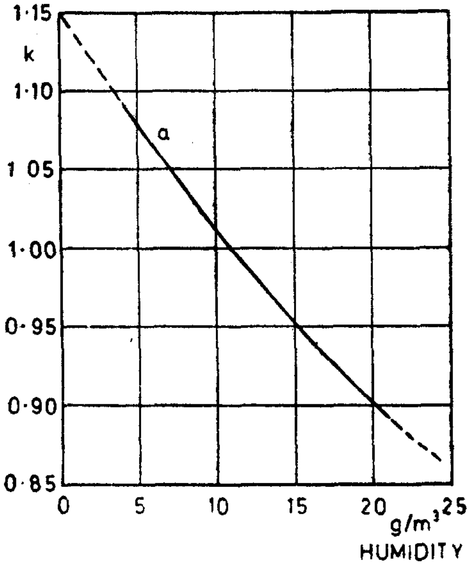


FIG. 3 CORRECTIONS FOR HUMIDITY FACTOR k_h *versus* ABSOLUTE HUMIDITY



($k_h = k^m$ with *m* given in Fig. 2)

FIG. 4 HUMIDITY CORRECTION FOR DRY POWER-FREQUENCY VOLTAGE TEST — FACTOR *k versus* ABSOLUTE HUMIDITY

APPENDIX B

(*Clause* 9.1.2)

SAMPLING AND CRITERION FOR CONFORMITY

B-1. LOT

B-1.1 All the post insulators of the same size and design manufactured under similar conditions of production, offered for acceptance of lot; may consist of the whole or part of the quantity offered.

B-1.1.1 Samples shall be taken from each lot and tested for conformity.

B-2. SCALE OF SAMPLING

B-2.1 The number of post insulators to be selectd from each lot shall be according to Table 1.

TABLE 1 SCALE OF SAMPLING AND PERMISSIBLE NUMBER OF DEFECTIVES

Lot Size (1)	Stage (2)	Sample Size (3)	Cumulative Sample Size (4)	Acceptance Number (5)	Rejection Number (6)
3 to 300	First	3	3	0	2
	Second	3	6	1	2
301 to 500	First	5	5	0	2
	Second	5	10	1	2
501 to 1 000	First	8	8	0	2
	Second	8	16	1	2
1 001 to 3 000	First	13	13	0	2
	Second	13	26	1	2
3 001 and above	First	20	20	0	2
	Second	20	40	1	2

B-2.2 The post insulators shall be selected at random. In order to ensure the randomness of selection, procedures given in IS : 4905-1968* shall be followed.

B-3. NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

B-3.1 The number of post insulators to be selected at random in the first stage shall be in accordance with col 1 and 3 of Table 1. Each of the selected post insulator shall be tested for the acceptance tests. If a post insulator fails in any one of the acceptance tests, it shall be termed as ' defective '. The lot shall be declared as accepted if the number of defectives found in the sample is less than or equal to the acceptance number (*see* col 5) and shall be rejected if it is greater than or equal to the rejection number (*see* col 6). In case the number of defectives lies between the acceptance number and rejection number, the second sample of the same size shall be chosen at random and tested. If the number of defectives found in the combined samples is greater than or equal to the rejection number, the lot shall be rejected, otherwise the lot shall be accepted.

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*Methods for random sampling.